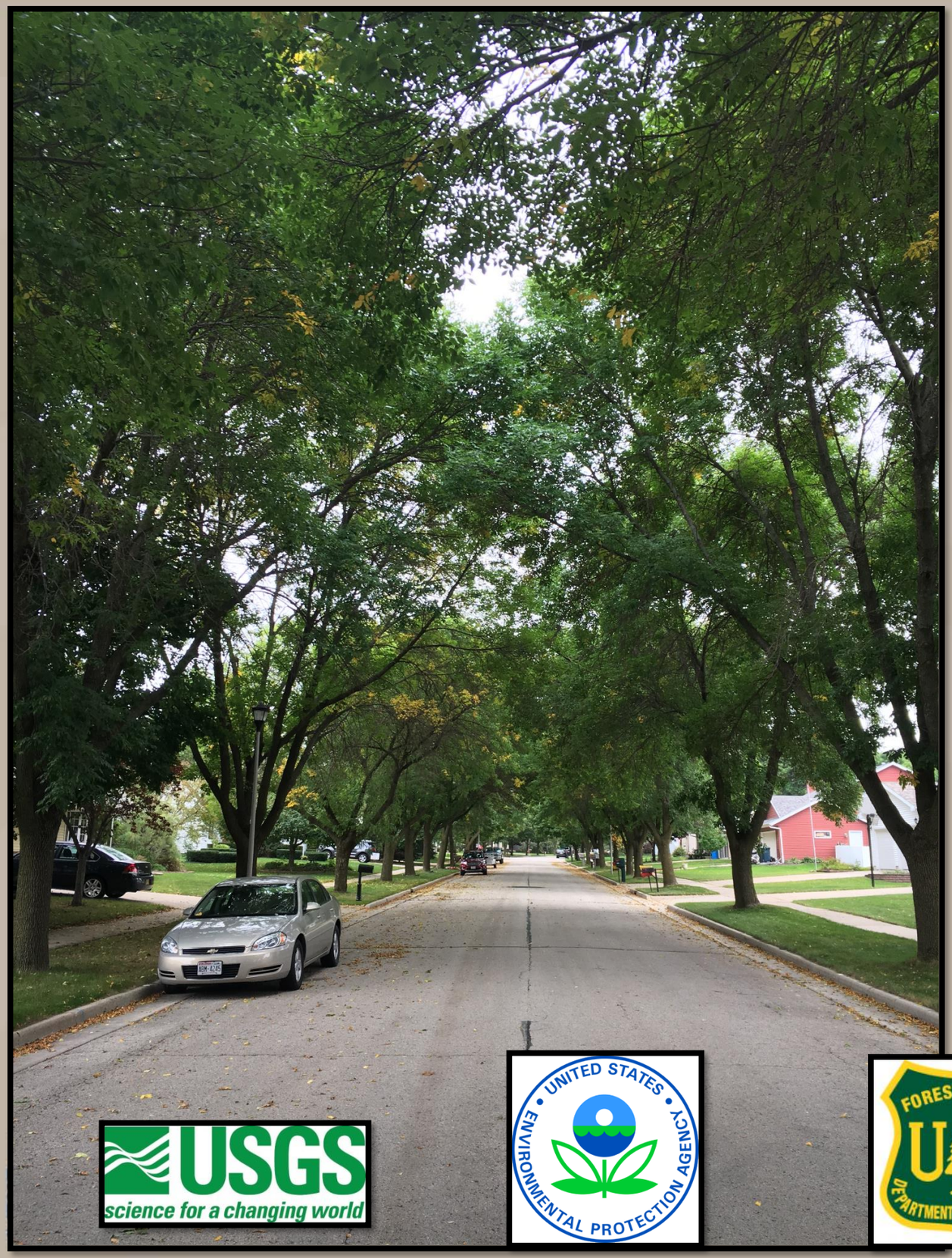
Monitoring and Predicting the Impacts of Trees on Urban Stormwater Volume Reduction



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U.S. Forest Service

Steve Loheid, William Avery, Dominic Ciruzzi, Carolyn Voter, Brian Schlaff
University of Wisconsin Madison

Bryant Scharenbroch
University of Wisconsin Stevens Point

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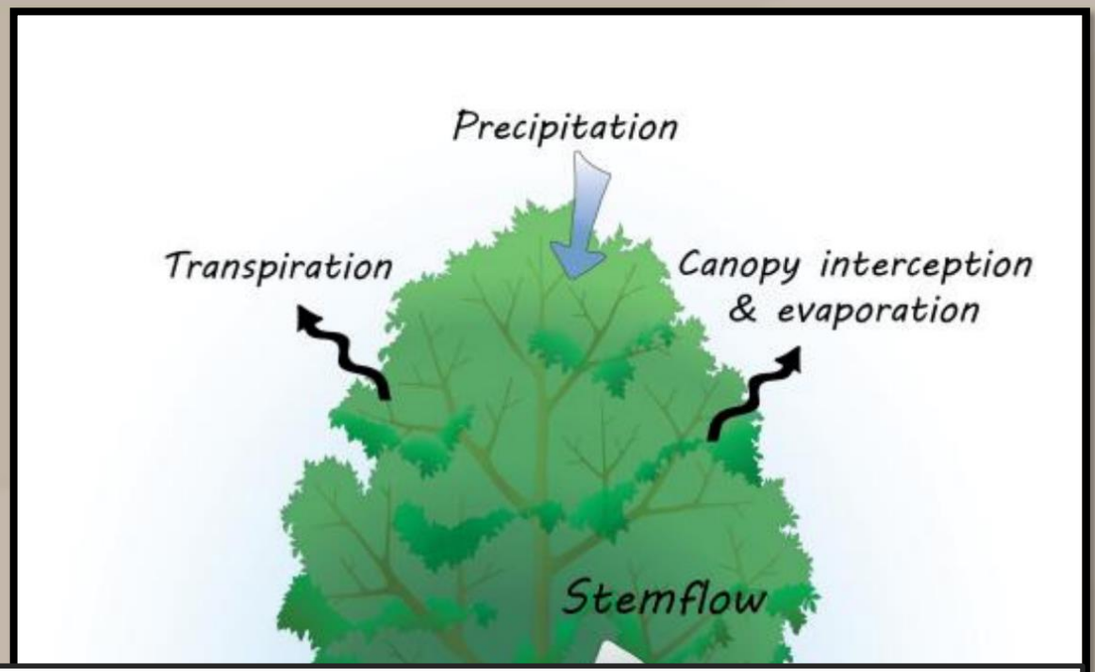
City of Fond du Lac

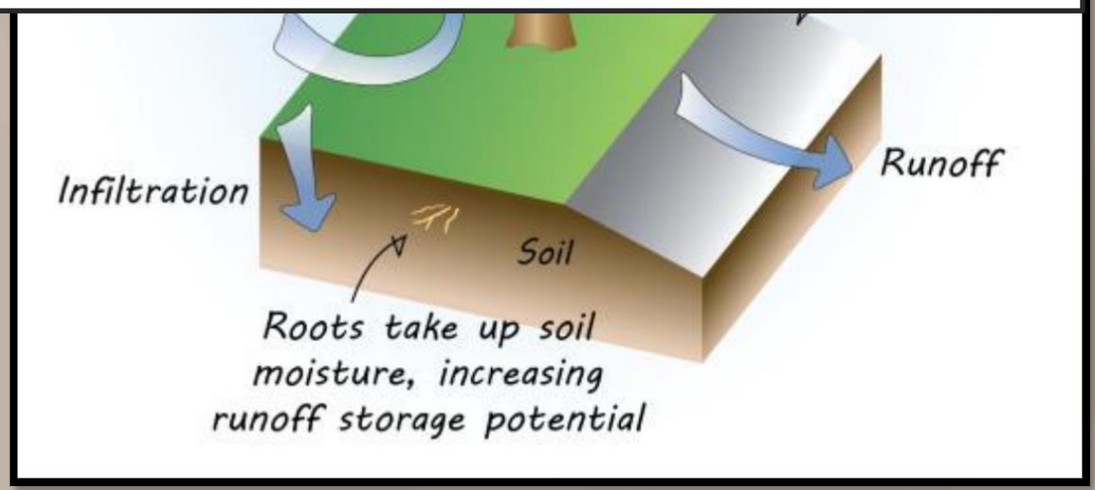
Why do we care?

Trees are an increasingly important part of stormwater management

- Washington D.C. – 46% tree canopy reduces need for 949 million ft^3 of stormwater retention. This saves $4.7 with 19 million additional cubic feet of stormwater
- California Central Valley – For every 1,000 trees, stormwater is reduced by 1 million gallons



"…inadequate research quantifying the urban tree contribution to rainfall/runoff processes limits their promotion by stormwater managers" Kuehler et. al., 2016



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Great Lakes Restoration Initiative - Lake Michigan Drainage Basin

Fond du Lac, WI

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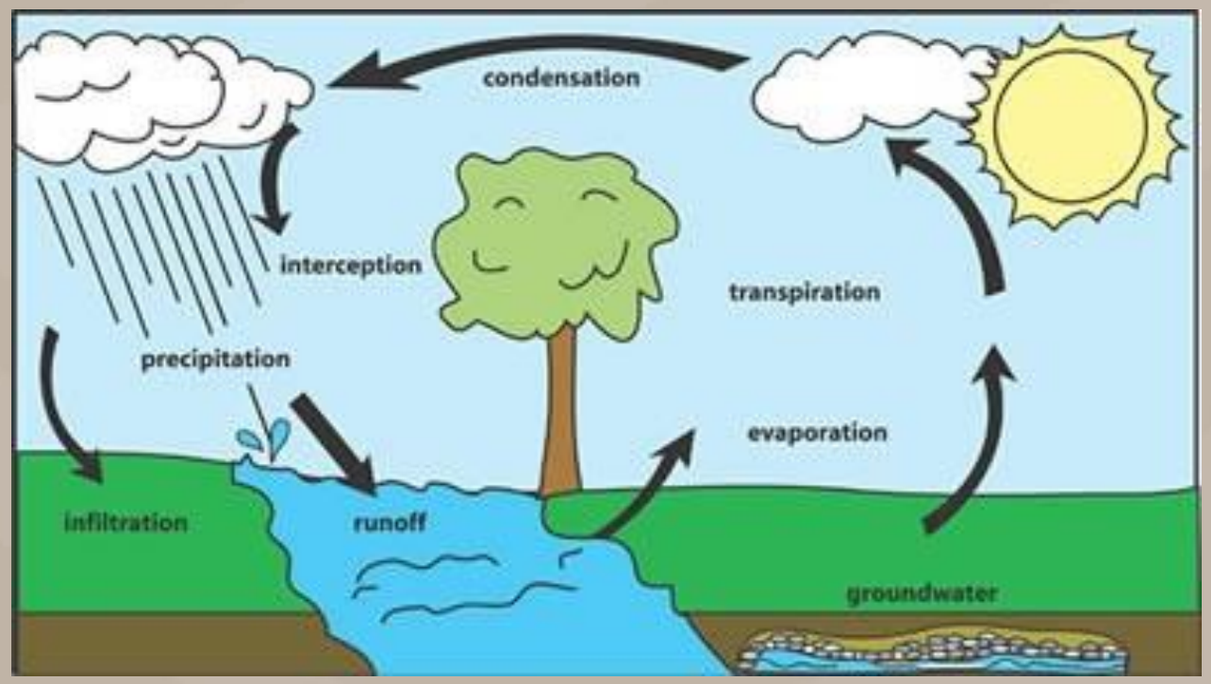
Conceptual Model

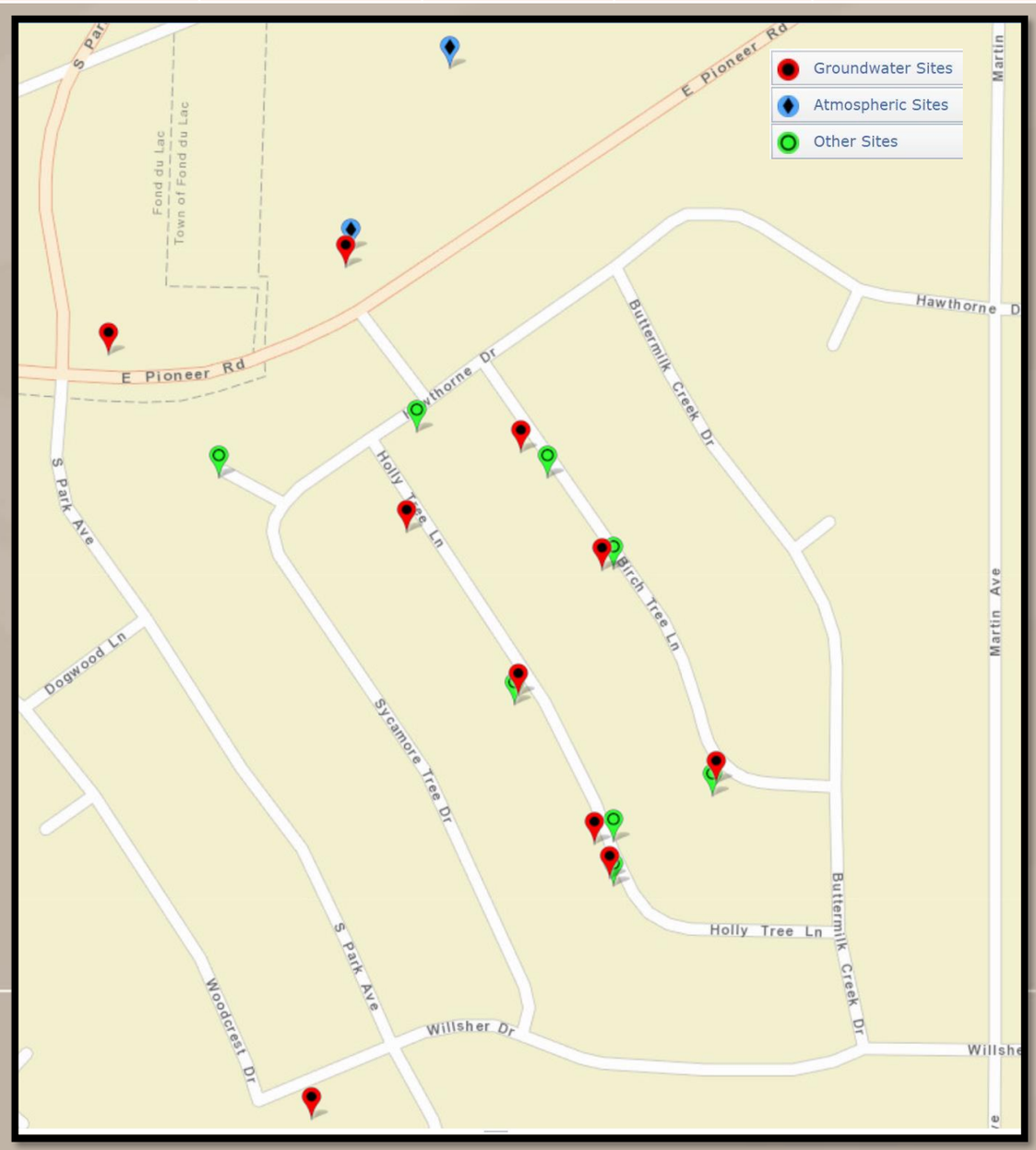
- ✓ Determine volume of stormwater urban trees keep out of storm drains
- ✓ Use microclimate data to improve predictive capability of i-Tree
  - Measure
    - –**R**unoff
    - –**P**recipitation
    - –**E**vapotranspiration
    - –**I**nfiltration
    - –**S**torage
  - Model
    - –i-Tree



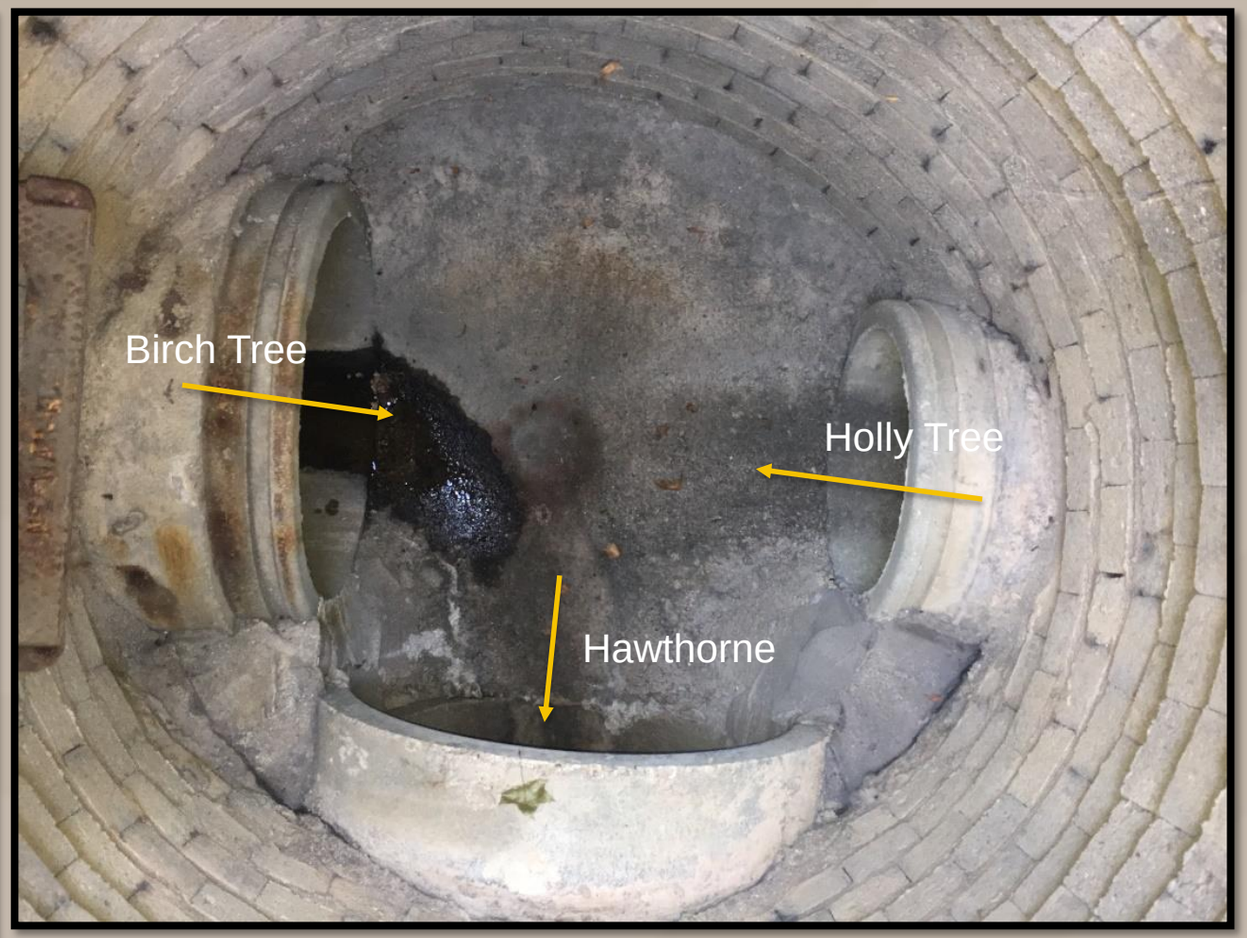
Urban Hydrologic Cycle:

$$R = P – E – I - S$$

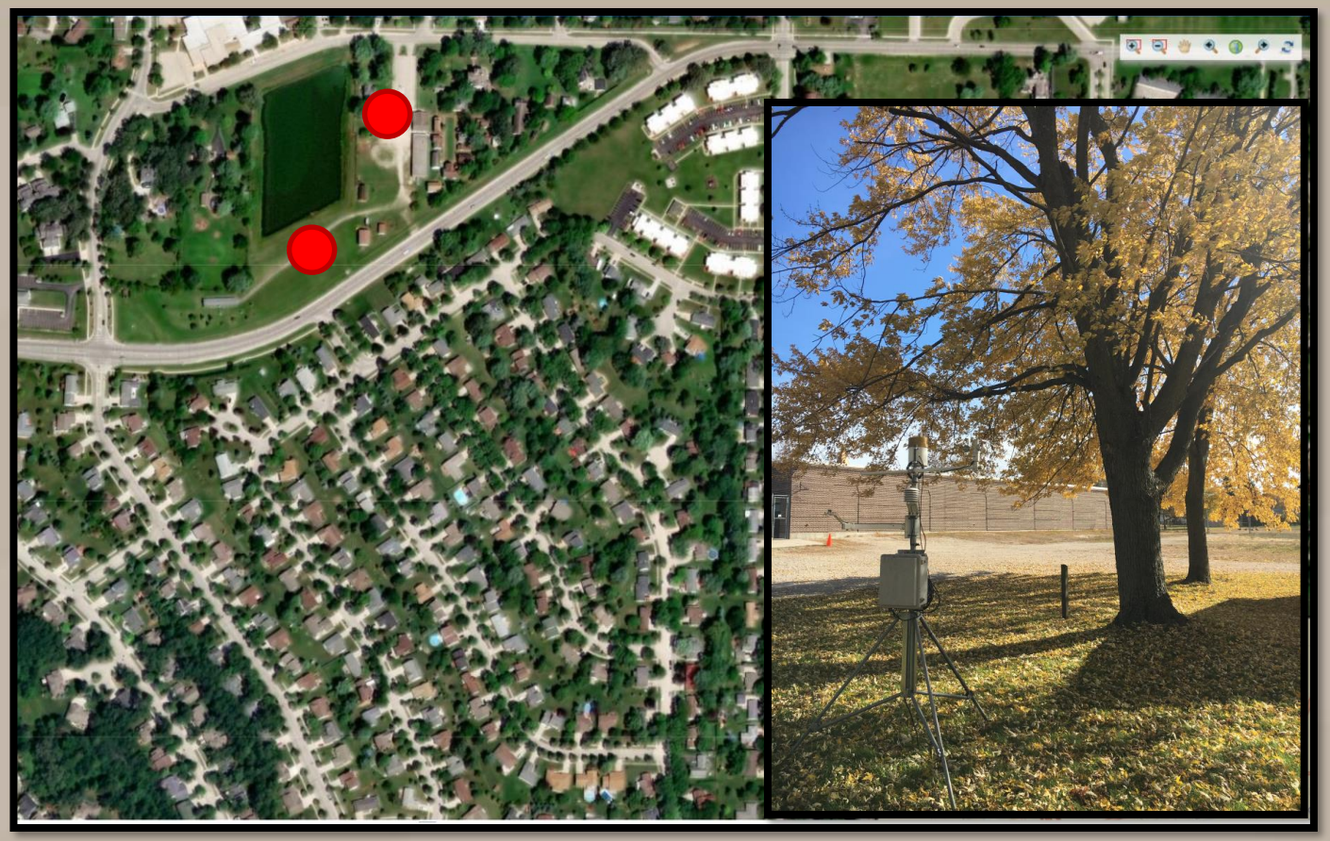
Area (sq. ft.)	CONTROL (Holly)	% of Total	TEST (Birch)	% of Total
Total area	**219,215**	--	**458,277**	--
Tree canopy	54,567	25%	129,219	28%
Tree canopy over impervious	23,475	43%	39,338	30%
Tree canopy over pervious	31,092	57%	89,880	70%
Impervious cover	120,935	55%	191,309	42%
Pervious cover	98,280	45%	266,968	58%



Surface Runoff

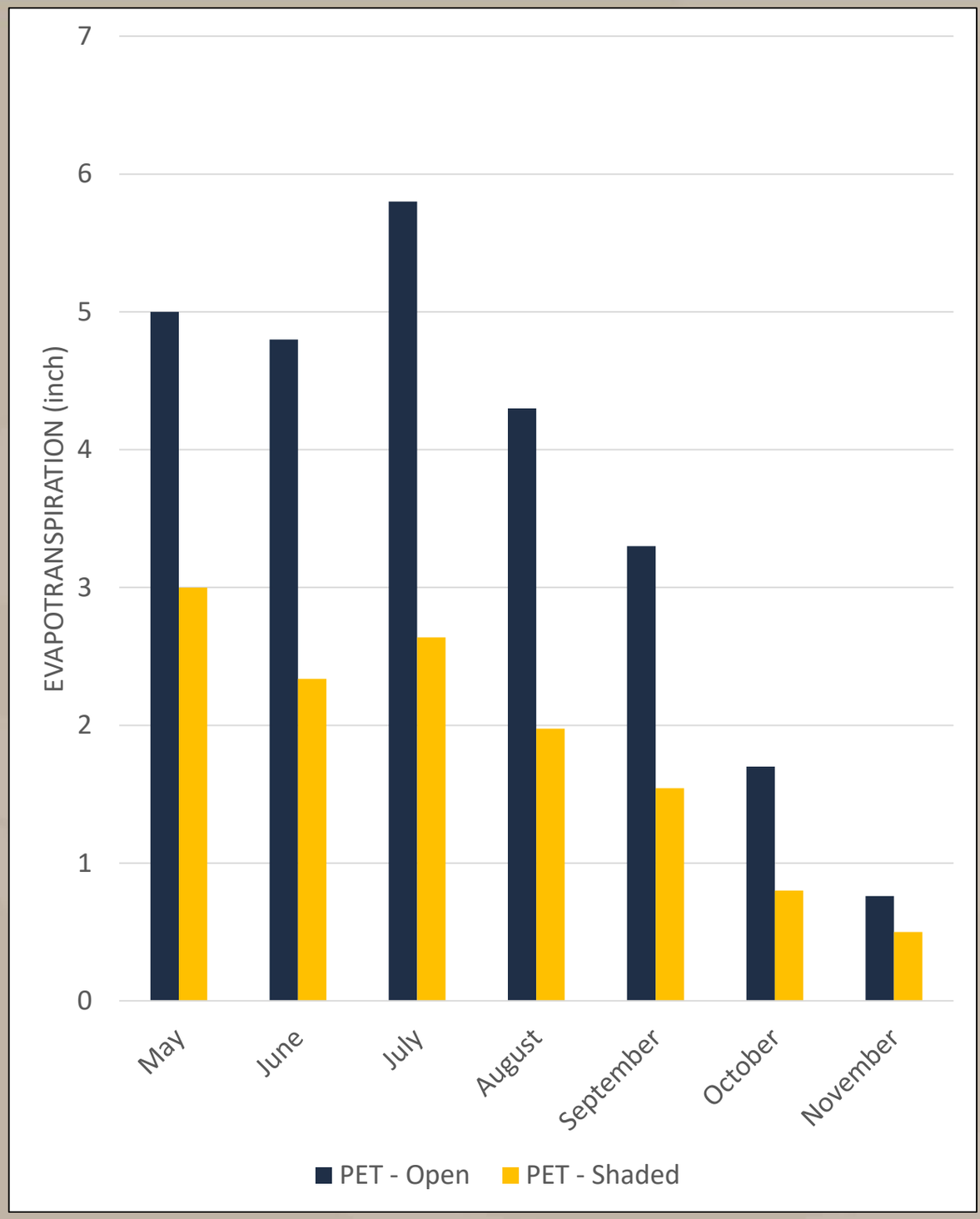


Climate Inputs and Losses

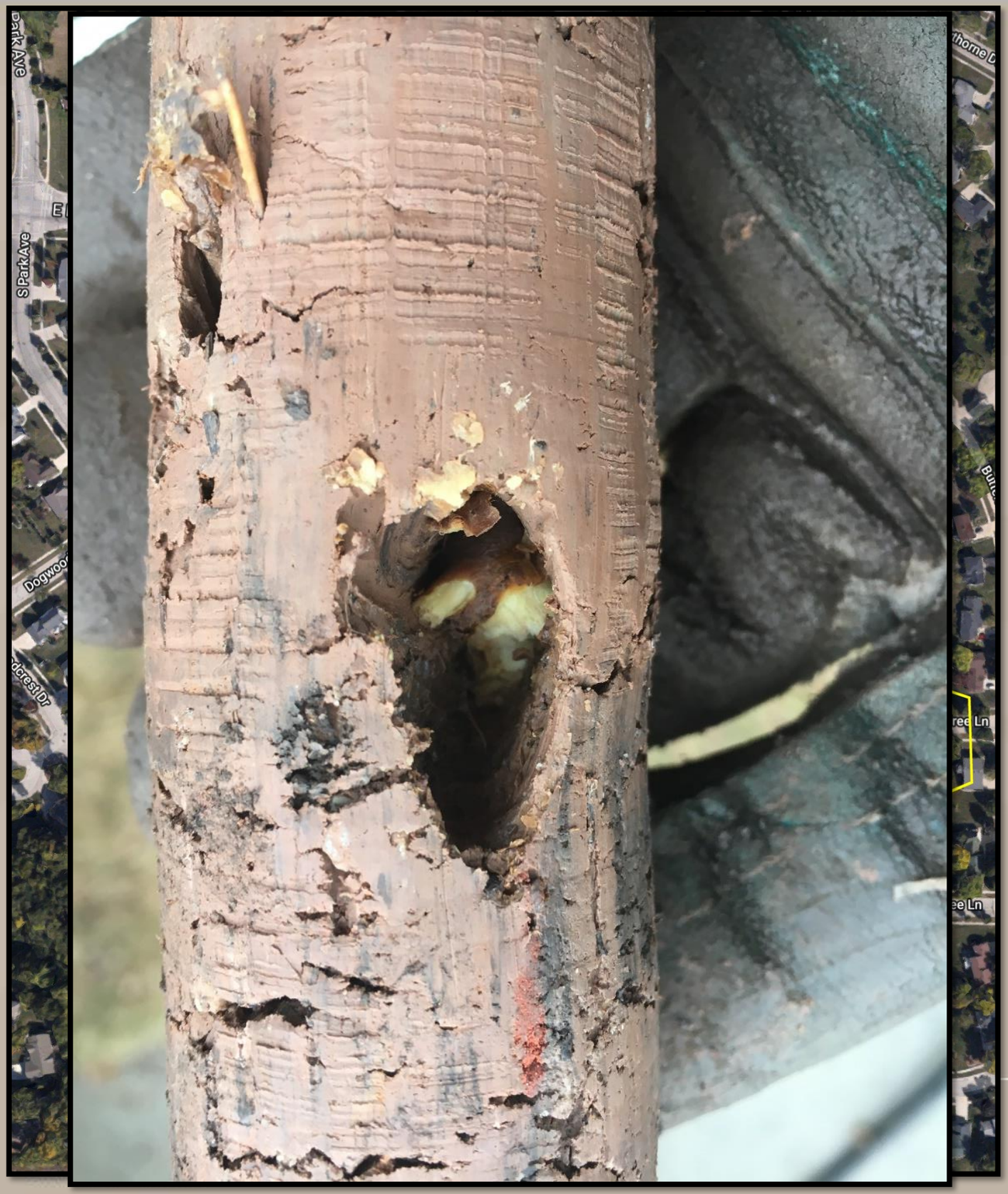


Potential Evapotranspiration (PET)

- Precipitation
- Solar radiation
- Wind speed
- Relative Humidity
- Air temperature



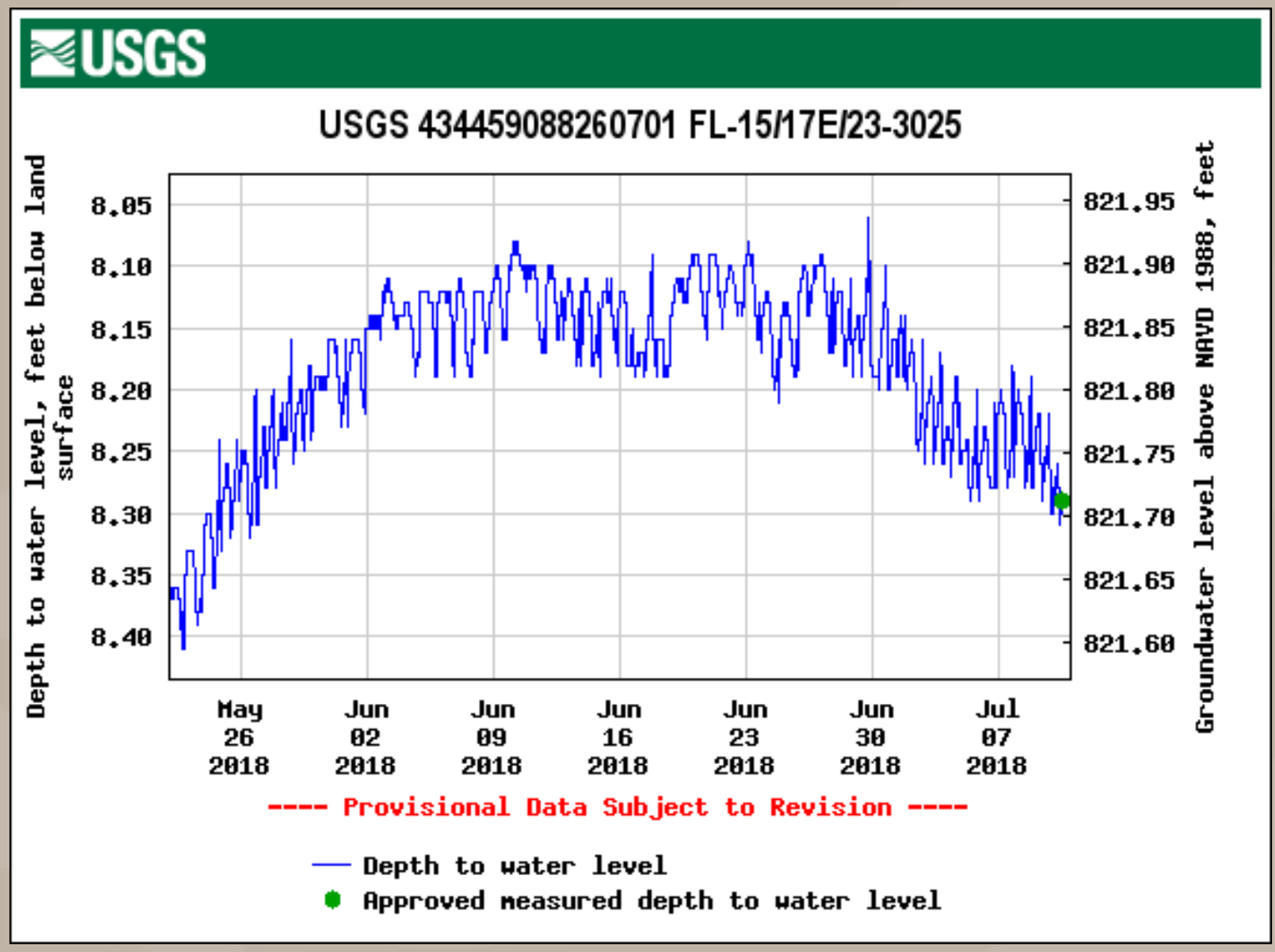
Sub-surface flow



Sub-surface flow

Soil moisture in vertical profile allows us to see how much and how fast water infiltrates into the soil. We can also detect when trees and grass consume water during dry periods

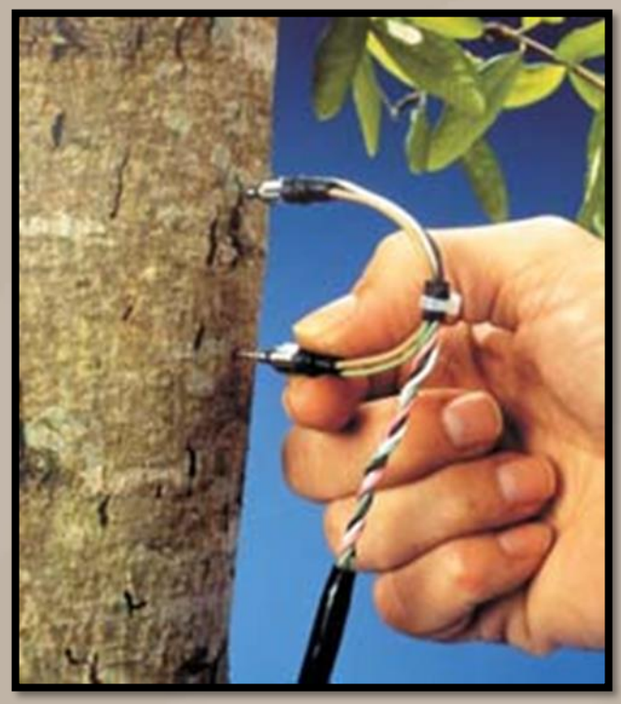
Groundwater Monitoring



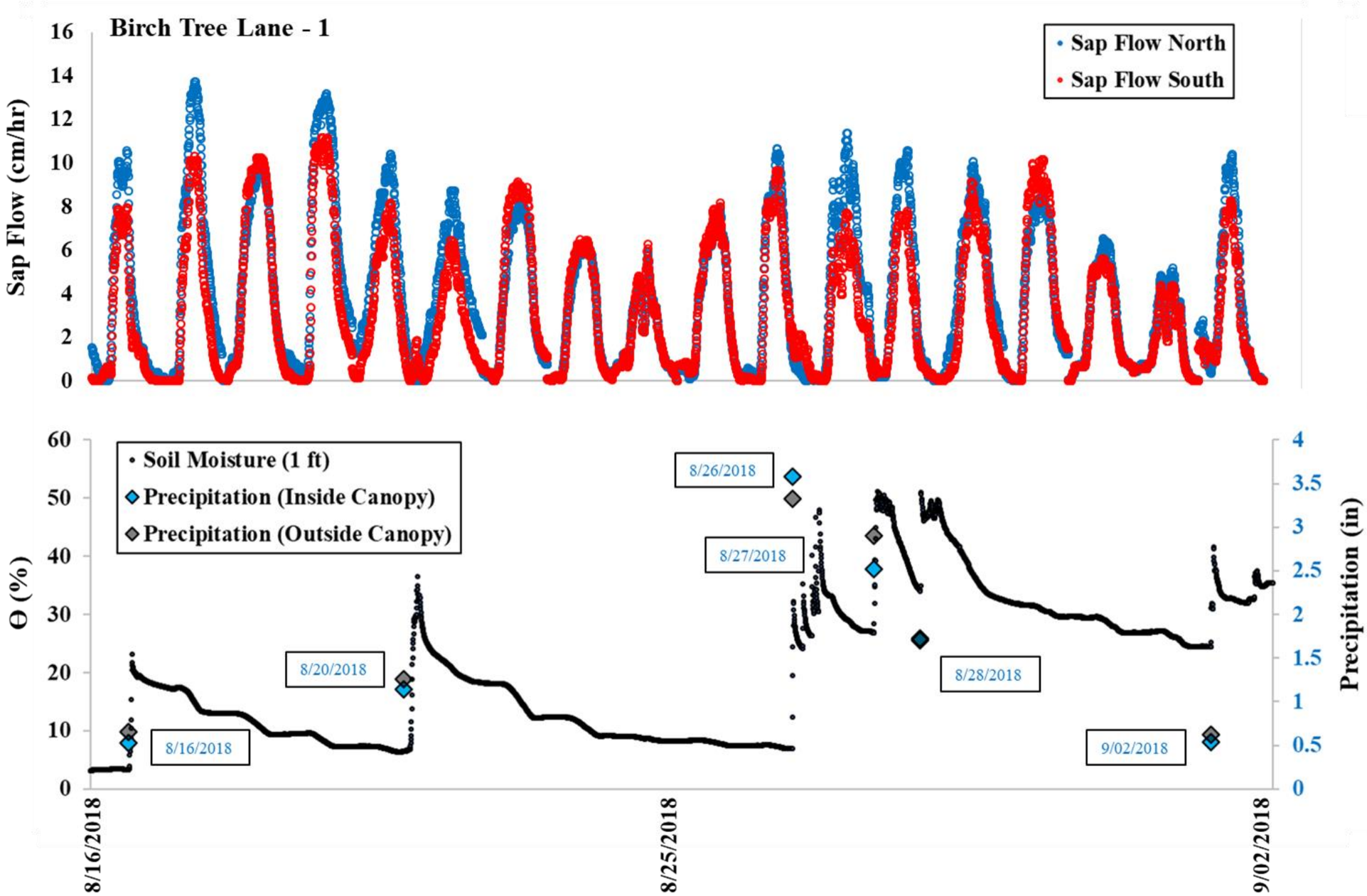
Changes in groundwater level can indicate water consumption as roots tap into deeper sources of water

Aboricultural Water Consumption

Sap flow sensors

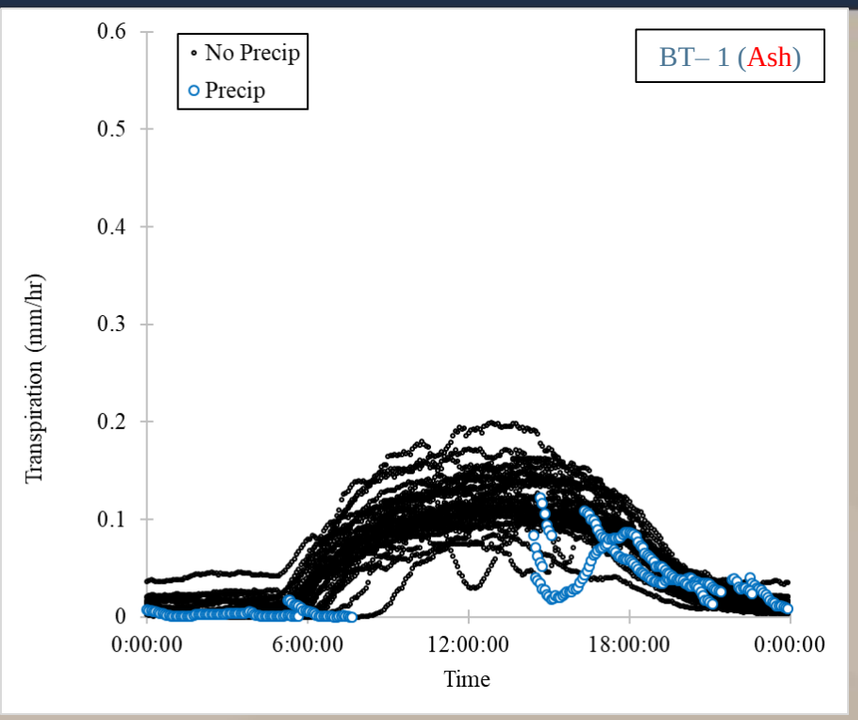


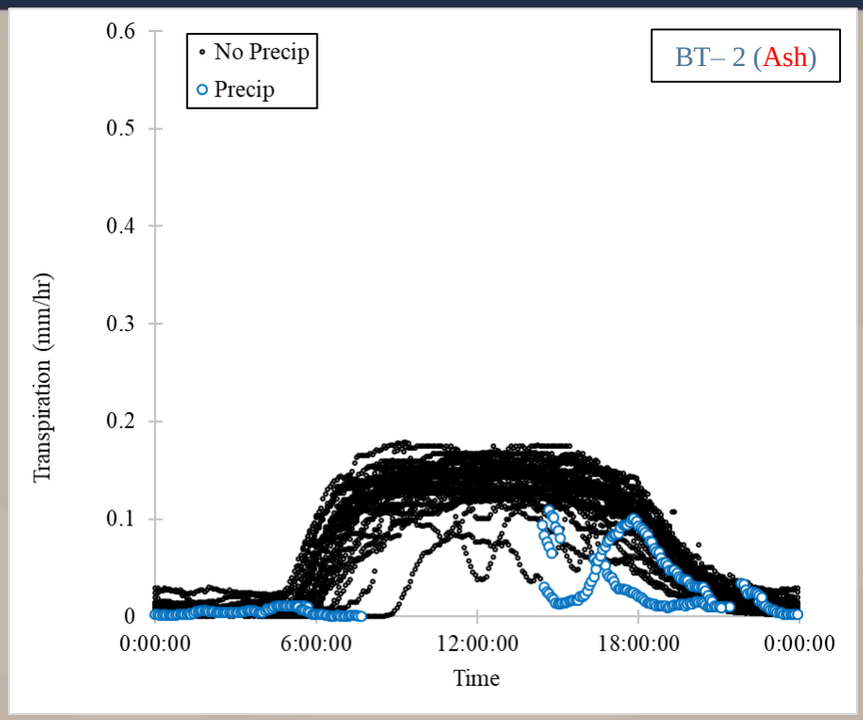
By measuring the ratio of heat transported between two symmetrically placed temperature sensors, the magnitude and direction of water flux can be calculated

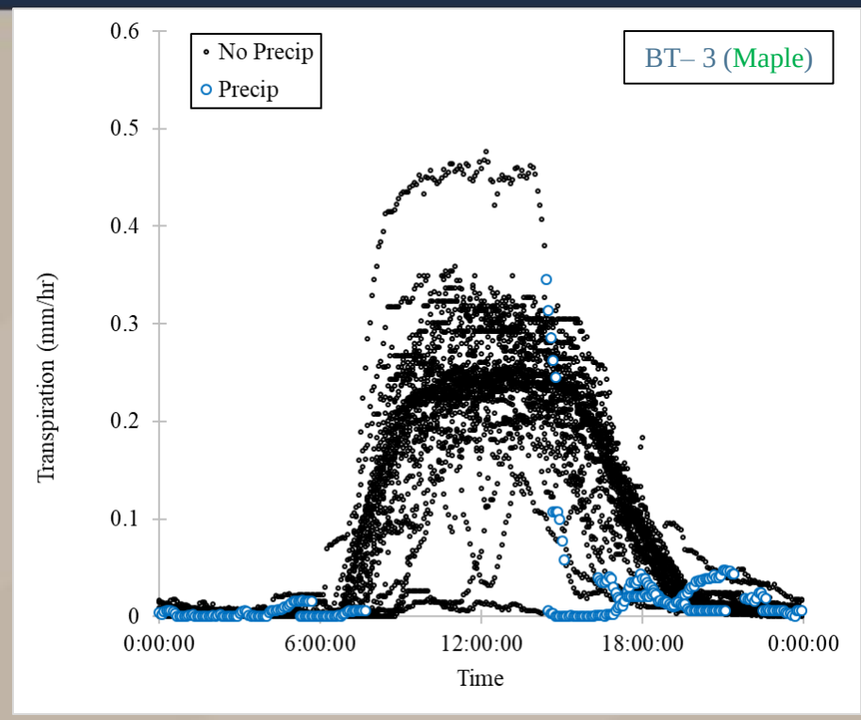


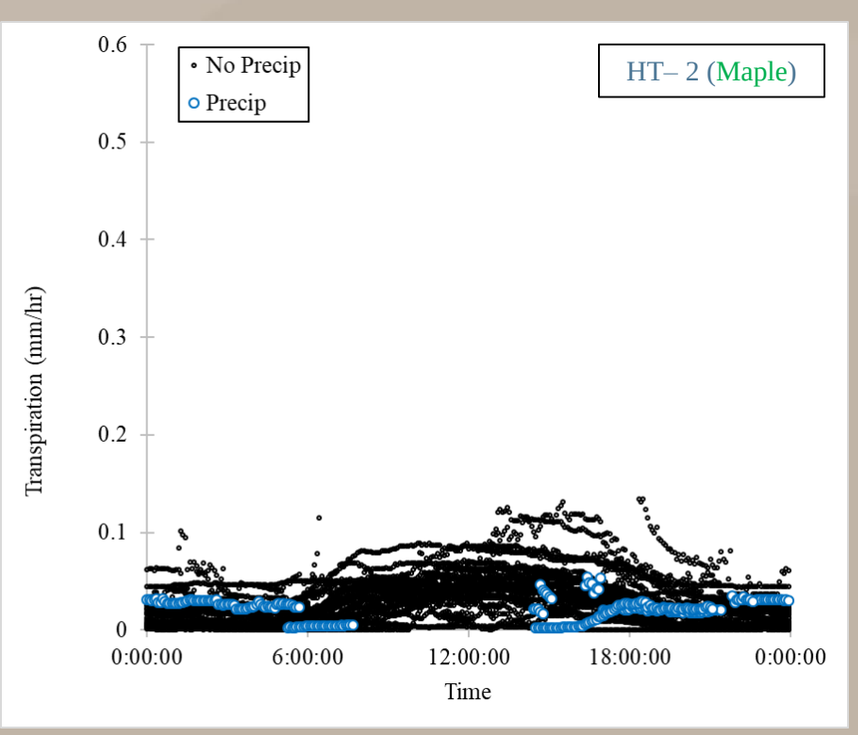
Velocity of sap movement within ash trees shows limited sensitivity to soil moisture changes in the top 1 foot of the soil profile, likely due to abundant moisture during summer 2018. Weather conditions are the dominate driver of temporal variation in transpiration.

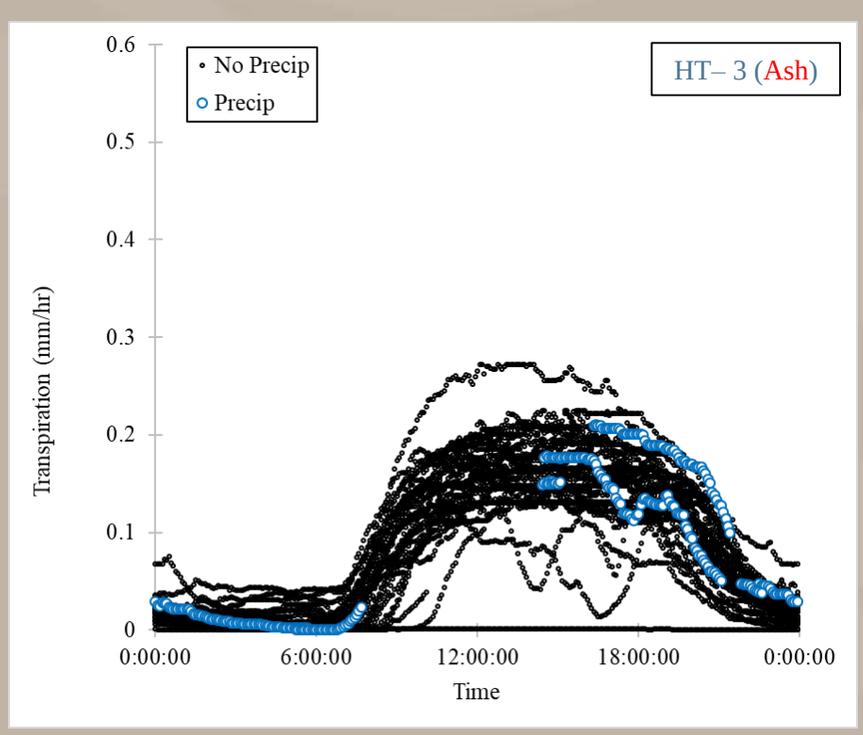
Source: William Avery

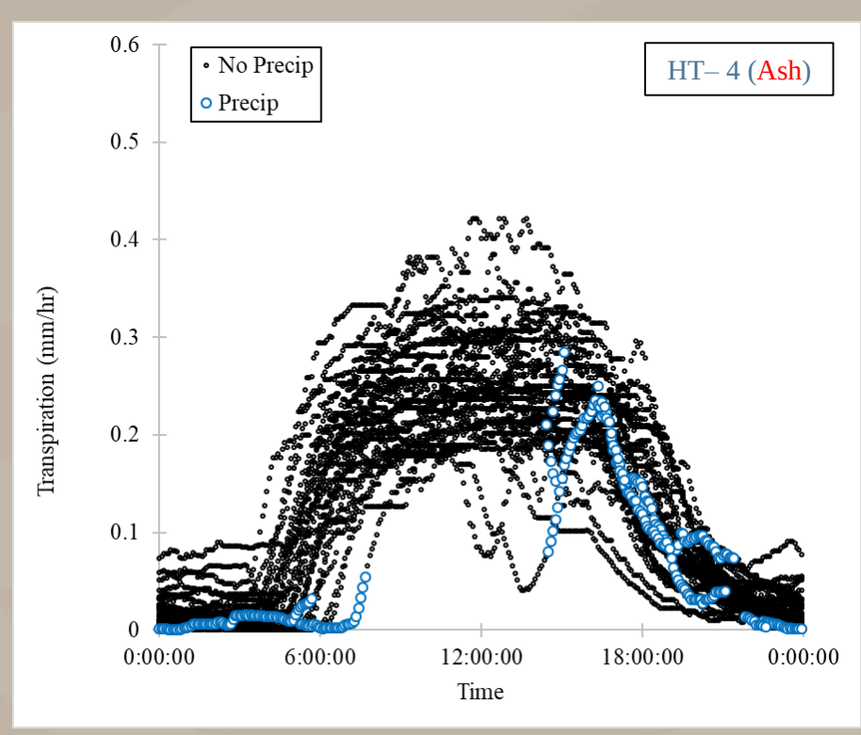












Source: William Avery

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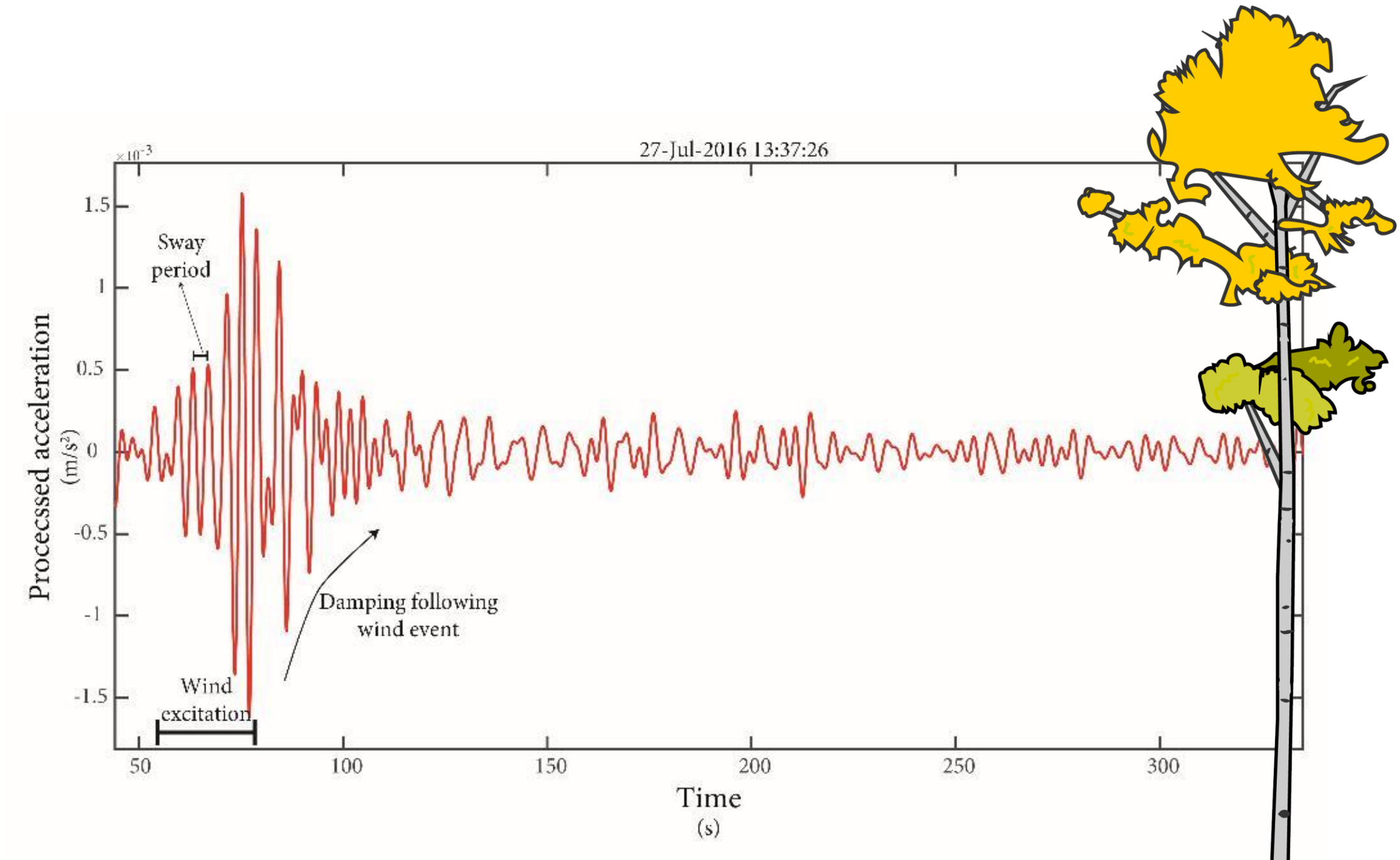
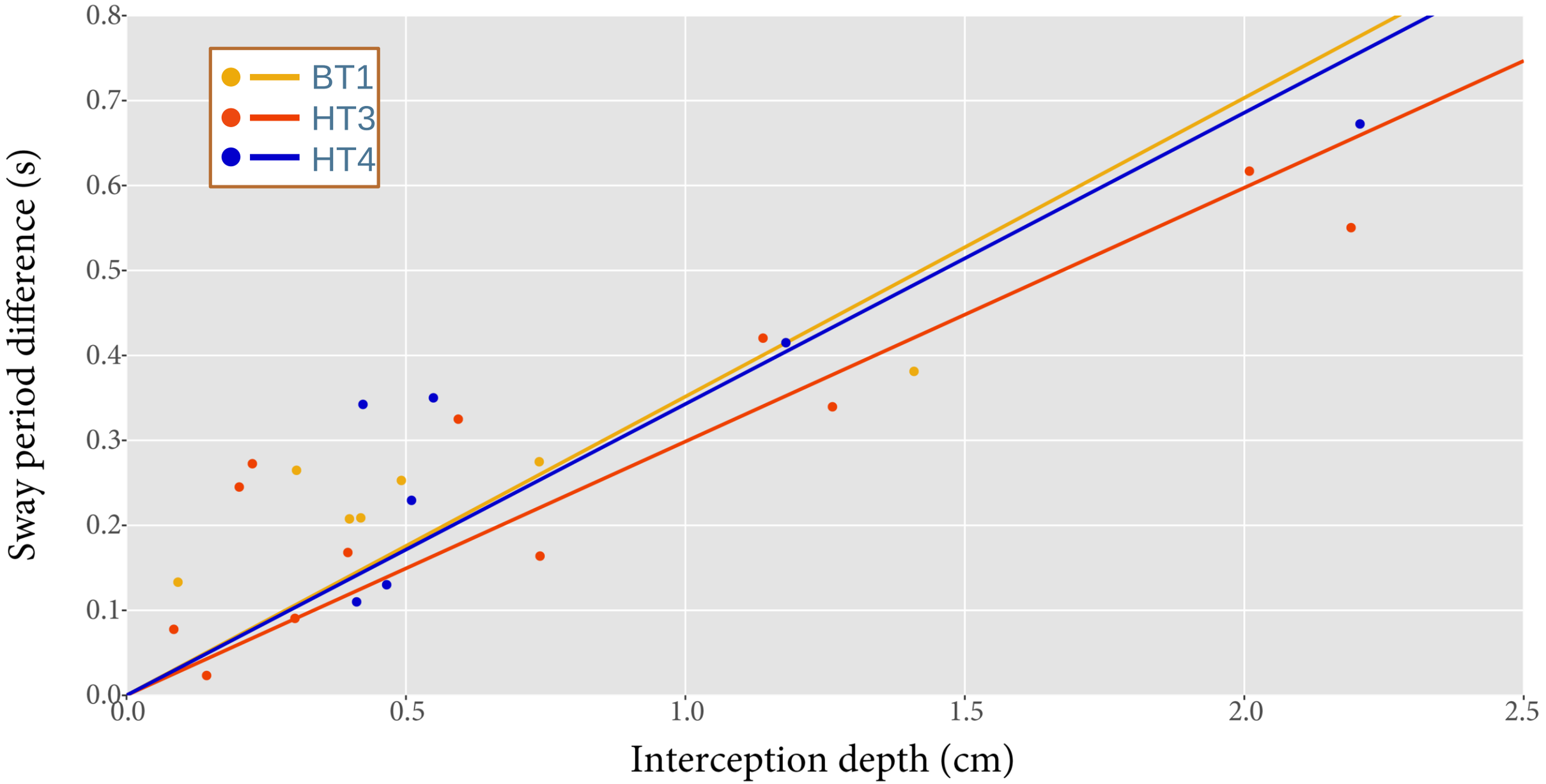
Processing sway signals



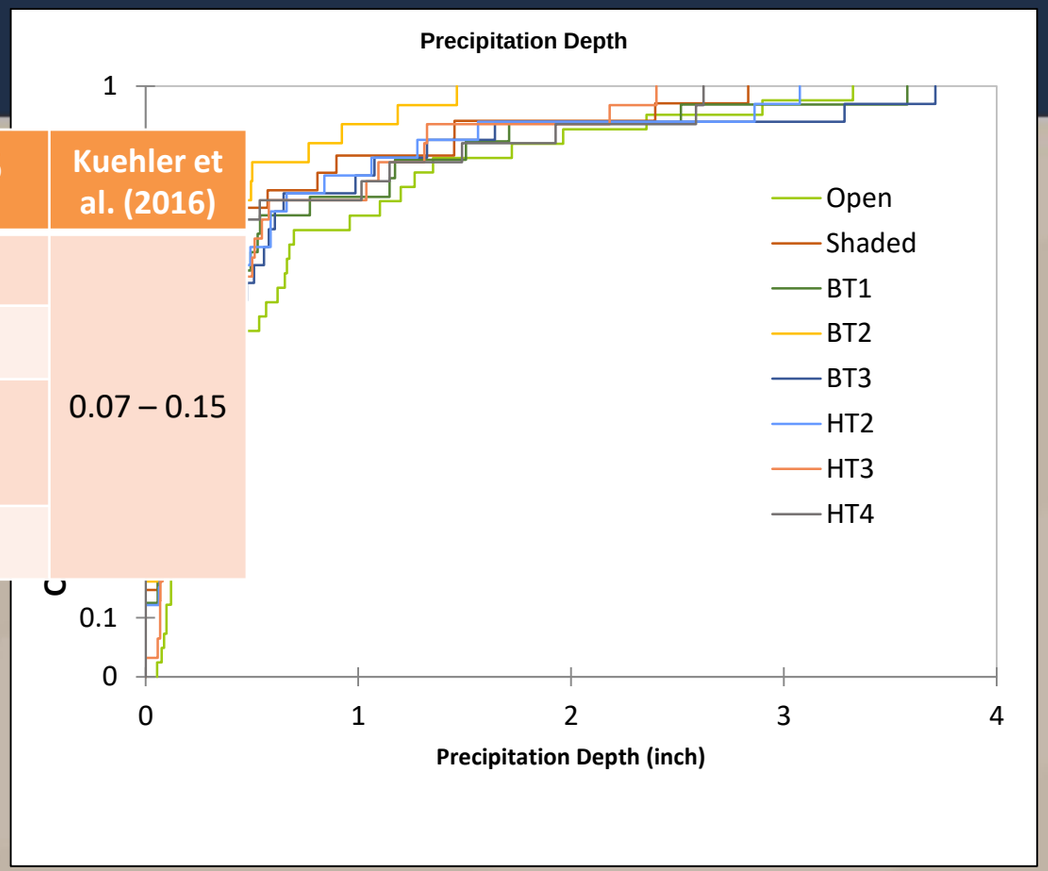
Source: Dominic Ciruzzi

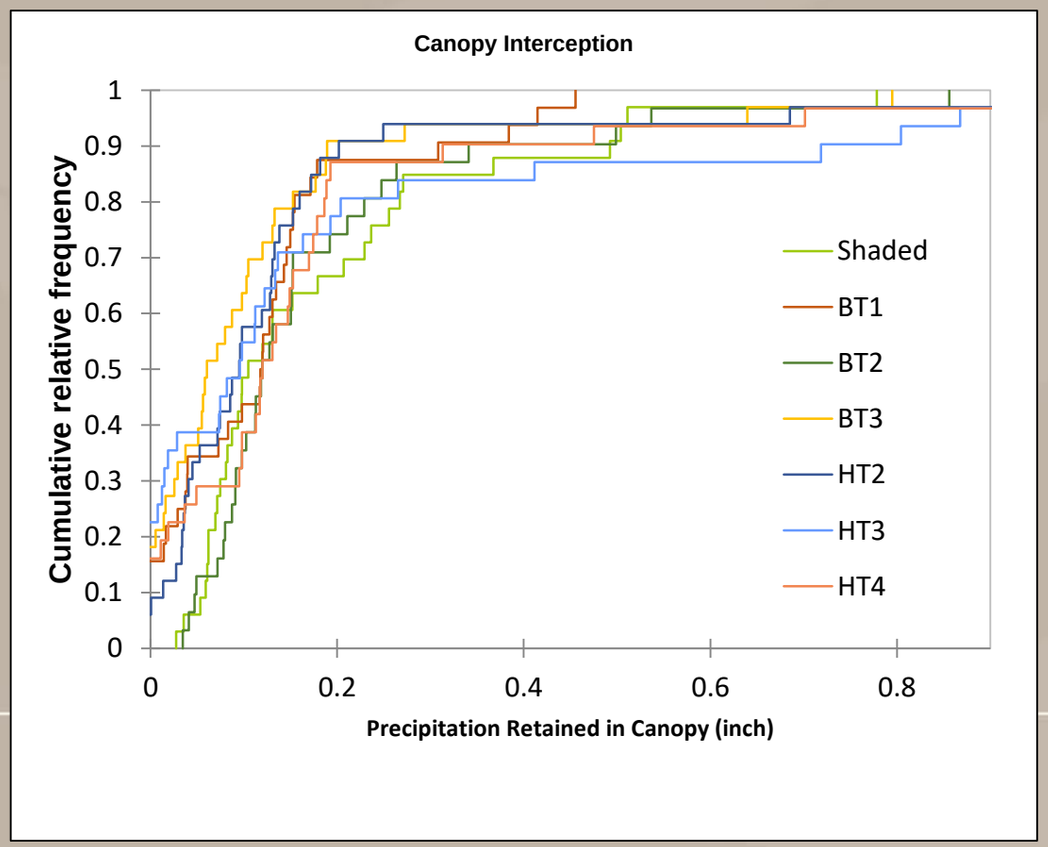


Source: Dominic Ciruzzi

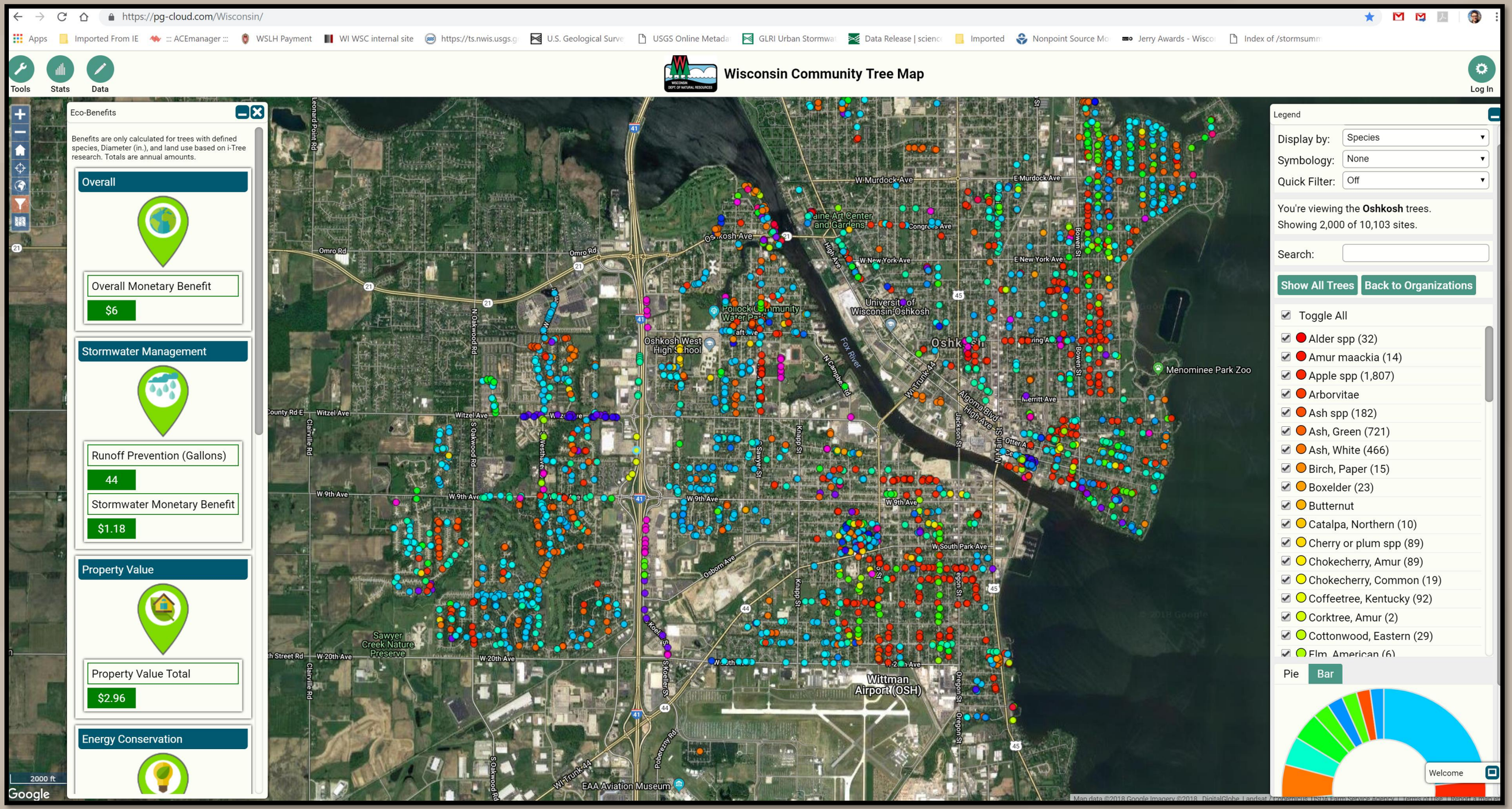
Canopy Interception

Statistic	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Kuehler et al. (2016)
Mean (inch)	0.09	0.19	0.08	0.15	0.18	0.13	0.07 – 0.15
	avg. = 0.14 (29%)						
Median (inch)	0.12	0.12	0.06	0.09	0.09	0.11	
	avg. = 0.10 (30%)						





Modeling (i-Tree)



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Monitoring and predicting the impacts of trees on urban stormwater volume reduction

Overview Related Science Maps Partners

Much has been learned about how effectively individual green infrastructure practices can reduce stormwater volume, however, the role of urban trees in stormwater detention is poorly understood. This study will quantify the effect of tree removal on the urban hydrologic cycle and measure the impact that trees have on stormwater runoff volume.

BACKGROUND

The use of green infrastructure in urban areas has increasingly been accepted as a means to reduce adverse impacts of stormwater on sewer systems that service Great Lakes communities, and to a larger degree, Great Lakes water quality. Over the last decade, much has been learned about how effectively individual green infrastructure practices can reduce stormwater volume; however, one element that remains poorly understood is the role of urban trees in stormwater detention. Research is needed to provide quantitative data on how

Status - Active

Contacts

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Urban tree study explained Oct 4

Have you noticed the weird foil wrapping on some
Geological Survey, will explain it all at 6 p.m. Thursc

The foil wrapping and other devices are helping res
Madison in their work for the Great Lakes Restorati
stormwater runoff. The scientists want to understar
and back into lakes and rivers.

There are many components to the whole-water cy
quality of stormwater in relation to how cities mana
they work to protect and restore the largest system

UW-Madison Center for Limnology

The Study, Science & Stories of Our Inland Waters

Out of the Woods, Into the Trees: Trout Lake Research on the Streets of Fond du Lac

August 3, 2018 Adam Hinterthuer Leave a comment

This is Part 3 of a 3-Part series on an ambitious summer research project exploring how trees manage their water supplies and respond to drought. You can read Part 1 here and Part 2 here.

"The lake is the one true microcosm, for nowhere else is the life of the great world, in all of its intricacies, so clearly disclosed to us as in the tiny model offered by the inland lake." E. A. Birge, 1936, "A House Half Built."

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GENERAL ALERT Sinclair Cares: Hurricane Michael fund

Foiled trees help scientists study storm water

by Gabrielle Mays, FOX 11 News | Sunday, October 7th 2018

An urban tree study in Fond du Lac is measuring how much water trees retain and keep out of storm drains. (WLUK/Mike Gard)

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